BLUE RIVER WATERSHED TRIP REPORT

Final
Blue River Watershed Trip Report
Apache - Sitgreaves National Forest
October 31-November 2, 2000

5/31/2001

I. Introduction

At the request of the Apache - Sitgreaves National Forest the National Riparian Service Team (NRST) traveled to Springerville, Arizona October 31 - November 2, 2000. The NRST was represented by Wayne Elmore (Team Leader), Steve Leonard (Ecologist/Grazing Management Specialist), Lisa Lewis (Soil Scientist/Road Management Specialist), Janice Staats (Hydrologist), and Ron Wiley (Fisheries Biologist). The purpose of the trip was to provide technical assistance on riparian and fish habitat management in the Blue River and it's watershed. We made visual assessments of the watershed and selected reaches. On two reaches (Baseline on the mainstem and Bush Creek) we completed a PFC assessment checklist (attached). The PFC assessment was conducted using the protocol described in BLM Technical Reference TR 1737 - 15 *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas.*

It should be made clear that the NRST has no decision making authority. Our role, when engaged in technical assistance trips, is to provide technical opinions and advice which the requesting line officer can then use in conjunction with other information they have to make appropriate decisions. Therefore, the information contained within this report should not be considered as direction but rather as information to be used by the Apache - Sitgreaves National Forest and its stakeholders in developing direction. In our brief time in the Blue river watershed we were of course unable to examine all corners of the watershed. We were able to overfly a large portion of the watershed which greatly increased our perspective of watershed scale processes. During our field visit we flew the entire mainstem as well as several major tributaries and drove the length of the county road. We also hiked portions of Bush Creek. Therefore, many of our recommendations are by necessity more generalistic than specific in nature. They are intended as "food for thought" when addressing management within the watershed. As always, it will take the collaboration of local people with local knowledge and experience to design the site specific plan necessary to successfully allow the watershed to restore itself. We sincerely hope that we have provided a base from which the Forest and its stakeholders can work to develop a watershed scale strategy which builds on ongoing management successes coupled with new management direction designed to further solidify and advance recovery efforts for the Blue River watershed.

Major issues to be addressed included;

1. T&E fish habitat (spikedace & loach minnow),
2. contribution of county road to sediment load of Blue River,
3. county's use of inchannel gravel for road maintenance,
4. lack of riparian vegetation cover and diversity,

5. impaired function of channel/floodplain, and
6. potential impacts and benefits of proposed fish barrier near mouth of Blue River.

The trip objectives, of the Apache - Sitgreaves National Forest, for the NRST were to;

1. assess current condition, as well as future potential, of Blue River riparian communities - including PFC assessment of major reaches,
2. assess current condition, as well as future potential, of fish habitat in the Blue River,
3. provide opinion on impacts from current, as well as historic, management activities,
4. provide opinion on relative importance of individual impacts, i.e., watershed scale picture,
5. provide management recommendations, and
6. provide opinion on realistic recovery time frames.

II. Executive Summary

The following report focuses heavily on the role of vegetation in stream channel stability - in concert, of course, with landform. This is a much studied relationship, therefore, for the sake of brevity rather than providing an in depth discussion on the subject within this report we refer the reader to such references as *Applied River Morphology* by Dave Rosgen and BLM Technical Reference TR 1737 - 15 *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas.* These references provide excellent overviews of the subject and provide additional references.

Vegetation and site characteristics, along the entire length of the Blue River, appear to have been severely altered by a number of major impacts. However, there is one area above Blue Camp that still appears to have many of the characteristics expected at potential. These negative impacts include, but may not be limited to:

- Removal of large wood. Discussions on-site and early photographs (no date) confirm that the Blue River was used for log transport down river. These logs were later used as charcoal for mining operations. Undoubtedly, the Blue River channel was "cleared" for transport. The removal of anchored trees, combined with the log floats, typically destabilize banks and scour any new regeneration of vegetation.

- Continuous year long grazing was the historical norm in this area, as was common throughout most of the Southwest. Continuous year long grazing would have limited recruitment of bank stabilizing vegetation and future supplies of large wood.

- Reduction in resistance forces (loss of large woody material and riparian vegetation, especially woody species) resulted in an increase in energy of water flow. The increased energy eroded the streambed and streambanks. This would have been significant enough to produce rapid vertical adjustments to the channel network, disconnecting the channel from it's frequent floodplain.

- Road construction, reconstruction, and maintenance, as well as lack of maintenance, further destabilized sites and again the channels were probably kept clear of large wood to minimize flood damage.

- Channelization and diking most likely induced, or at least contributed to, down cutting of the channel which reduced water tables and stressed any remaining vegetation. Much of the channelization and diking was probably associated with agricultural development which would have further reduced riparian functions of dissipating energy, trapping sediments, and storing water. On other segments this appeared to be mostly associated with road protection and maintenance.

Some, if not all, of these impacts appear to be continuing to one degree or another on some private lands within the Blue River catchment.

Despite the near complete de-stabilization of the Blue River, there is remarkable evidence of recovery, especially on the Forest Service administered lands. General management recommendations to ensure continuance of this trend are as follows.

First, road management strategies must be carefully designed to reduce fine sediment input into streams, avoid adding to the effective stream network, examine opportunities to reduce road density, ensure unimpeded fish passage to suitable habitat, and minimize road maintenance and repair activities which either remove riparian vegetation or prevent it's establishment.

An important point regarding "roads" and watershed effects needs to be made here. Typically road management strategies are limited to roads appearing on the Forest Development Transportation Facility. While this makes sense from a transportation management standpoint it falls short of adequately addressing all effects to watershed processes. Any route used by vehicles has the potential to adversely effect watershed processes, therefore, should be considered. Even foot and horse trails can contribute to degradation of watershed processes.

When conditions throughout the entire watershed are considered, however, it becomes evident that roads are one of many problems that need addressing but may not be "at the top of the list" of the watershed stressors. This means that care must be taken to avoid focusing too much time and effort on road problems at the expense of addressing larger watershed scale problems that left unattended will assuredly lead to the extinction of the listed species.

This statement is not intended to minimize effects roads have had or continues to have on the Blue River watershed. For example, the county road confines portions of the Blue River, straightening segments, increasing energy of water flow, and accelerating erosion of streambed, channel banks, and indirectly responsible for reactivating erosion processes (debris torrents) in tributary channels. Because of the proximity of the county road to the Blue River, however, problems will continue and stabilization efforts such as road maintenance and repair will be an ongoing challenge. Field observations revealed several opportunities to improve current road condition and decrease negative impacts to the river.

Second, in riparian areas grazing and browsing ungulates - both domestic and wild - must be managed to ensure that riparian plant communities can recover. On streams which need woody vegetation to achieve stability - as many in the Blue River watershed do - these plant communities must include those woody species which are part of the site potential. On an annual basis they must also be managed to ensure that adequate residual vegetation is left prior to normal high flow seasons and that mechanical damage to streambanks is minimal, i.e., doesn't carry over to the next year. In upland areas, residual ground cover must be left to provide for percolation as an aid in restoring "normal" hydrographs.

Third, timber management strategies must be designed to provide adequate recruitment of large wood to streams. These sources of large wood include areas adjacent to stream courses, including intermittent streams, and on unstable (landslide prone) areas which when they give way will deliver wood to the stream system. To aid in restoring "normal" hydrographs logging systems must be designed to minimize soil compaction and avoid damage to stream channels, including ephemeral channels. This last requirement can be somewhat difficult to implement due to problems in consistent identification of vulnerable channels. Ephemeral channels showing recognizable scour and deposition obviously need protection. However, areas which collect and direct water downslope can be vulnerable even when signs of scour and deposition are not readily identifiable prior to harvest activities. Disturbance to these, particularly when combined with increased surface run off from removal of vegetation, can result in the creation of "new" channels. Once these new channels have formed they will persist even after runoff returns to pre-harvest levels.

Fourth, non-native aquatic species must be addressed. The introduction of non-native species - both predatory and competitive - can have a profound impact on habitat selection and use by native species. Throughout the west - in fact throughout North America and worldwide - negative effects from introduced species are probably as big a problem facing efforts to restore healthy native aquatic communities as is habitat degradation. Unfortunately, correcting or even managing this problem is in many ways even more difficult than dealing with degraded habitat. Removal of introduced species is seldom if ever successful with other than chemical means and chemical control can cause unacceptable harm to the very communities one is trying to protect. What is typically left on the table is some combination of partial removal of introduced species, techniques to minimize or prevent re-invasion or population increases of the introduced species and restoration of habitat conditions which hopefully favor native species over the offending introduced species. The construction of the proposed fish passage barrier in the Blue River, if properly designed, can help control reintroduction of the offending species. It should be understood, however, that it is unlikely to be 100 % effective. The high bed loads carried by the Blue River necessitate a design that allows relatively unimpeded transport of this bedload. Such a design is likely to allow upstream fish passage at some flow. It is critical to recognize that this coupled with the impossibility of completely eradicating the existing population of offending species without also eliminating native species leaves a situation where continued control efforts will be required in perpetuity.

From the above discussion, it should be clear that to restore native aquatic communities in the Blue River, including currently listed fish species, the watershed must be restored. It should also

be clear that we do not restore watersheds. Our options are limited to removing, or managing, stressors for which we are responsible. Then and only then will the watershed itself begin the long process of restoring itself. Once we have dealt with human induced stressors the only thing left for us to do is to cultivate more patience - a lot of patience, more than we generally demonstrate. The watershed will eventually restore itself but the time frames can be nearly beyond our comprehension. In the meantime our tendency to "assist" should be carefully considered lest we do more harm than good and actually hinder the restoration process.

III. Background

Restoration of Aquatic Habitat and Recovery of the Loach Minnow *(Tiaroga cobitis)* and Spikedace *(meda fulgida)* Populations in the Blue River Watershed

When addressing this question it is important to remember the ultimate goal of the Endangered Species Act (ESA) is recovery of threatened and endangered species not just elimination of "take". This point is important when "legacy" effects exist. These effects arise from activities and/or practices that while long since abandoned never-the-less are responsible for effects which are still occurring. A common practice is to isolate actions which are currently occurring and analyze their effect on a species and it's habitat and to quantify or at least describe "take" occurring as a result of these adverse effects. Steps are then taken to eliminate these adverse effects, thus eliminating "take". While this may be effective in eliminating "take", if a significant portion of the species' problems stem from "legacy" effects then this approach may have little if any meaningful contribution to the recovery of the species. In fact in some cases the "legacy" effects may so greatly outweigh effects from current activities that these current activities are not resulting in "take" in and of themselves, i.e. the level of effect is lost in the "background noise" or in a perhaps tongue in cheek manner, once an egg is smothered from background fine sediment levels it can't be rendered any "deader" by the addition of more sediment from an on-going or new activity. Therefore, in these cases such an approach may not even result in an actual reduction in individual mortality.

In fact it can be argued that in some cases the pursuit of total elimination of "take", while well intentioned, may in fact reduce management options to the point at which recovery of the species is no longer possible. For example, road culverts often block upstream passage into suitable habitat needed for recovery of depressed fish species. If a policy of total elimination of "take" is pursued then these culverts cannot be removed or replaced as their removal or replacement would introduce sediment into the stream thus adversely effecting fish thereby constituting "take". Without removal or replacement of the offending culverts, suitable habitat available to fish may be inadequate to support recovery of the population, thus the population continues to decline. In this case, some level of "take" is necessary to allow actions which are required to ensure not only recovery of the population but in reality avoid extinction or extirpation.

However, it cannot be argued that consideration and management of "take" are not critical to the recovery of a species. It will do no good to restore a species' habitat if the population is lost along the way. What is clear is that total elimination of "take" does not by itself lead to the

recovery of a species and could actually hinder recovery. Therefore, when analyzing and managing "take" careful consideration must be given to whether steps required to manage "take" could actually hinder recovery or is even relevant to recovery.

If the elimination of take does not by itself lead to the recovery of a species and could actually hinder recovery, then what does? To answer this question one must first examine what drives aquatic habitat creation and maintenance, then apply this to the area of interest. Aquatic habitats are products of the geology and soils, topography, vegetation, climate, and hydrology of a watershed. Any change in these conditions can bring about changes in these habitats and their productivity. Additionally, a stream's channel and energy sources change from headwaters to mouth, and its biological community adapts accordingly. Therefore, aquatic habitat management should treat the stream/riparian ecosystem and in fact the entire watershed as a whole. Put simply - perhaps too simply - addressing watershed processes should take precedence over site effects. Of course, site effects must be examined to ensure that these effects don't result in the loss of the species over the short term. However, attention must also be paid to their relationship to watershed scale processes to ensure that time and resources are not spent on site impacts which have limited, or even no real relevance, to species recovery at the expense of addressing watershed scale issues critical to recovery of the species.

In the case of the Blue River, the river and it's watershed have been severely altered. Much of this alteration had already occurred by the early part of the twentieth century. Aldo Leopold went so far as to describe it in 1922 as "ruined".

He attributed this to overgrazing. However, the historic photograph below of a log drive, taken in 1909, suggests that a substantial amount of timber harvest had also occurred in the watershed.

The fact that the Blue River was subjected to log drives is important to any discussion of watershed restoration in that streams used for log drives were typically cleared and snagged to remove obstructions. In addition to the destabilizing effect of clearing and snagging, the log drives themselves did tremendous damage to the stream channel and banks.

The picture emerging from this information is that watershed processes in the Blue River watershed, as we see it today, are seriously compromised. The removal of wood from a stream channel to facilitate commercial use of the waterway may - will, if the stream requires wood to function properly as the Blue and many of it's tributaries do - destabilizes the channel thus causing degradation. Under these conditions each high water event flows unchecked downstream banging from side to side eroding the streambanks and preventing the reestablishment of vegetation needed to help restabilize the channel. The loss of wood from these streams also effects the transport and storage of sediments. Large wood functions to temporarily store sediments within the channel. It also functions to slow and backup water forcing flows out onto the flood prone area where sediments settle out. In turn, these deposits provide sites for vegetation to establish. Removal of this large wood leads to an acceleration in movement of sediment through the system.

Wood visible in the channel and on the surface of the flood prone area is not the only wood that is important to stream function. As streams naturally move (meander) across the valley bottom the rate of movement is not only controlled by both live vegetation and surface down wood but also by buried wood. Studies have shown that a great deal of the volume of the meander belt is composed of buried wood. One study found buried wood made up 30% of the volume of a stream's meander belt. This wood is long lived with life spans often measured in centuries, sometimes in thousands of years. Studies throughout the world arrive at similar results. Again, once this wood is removed the stream is free to bang from side to side with little resistance.

The preceding discussion was limited to the importance of wood to channel dynamics. However, this is not the only function of wood important to aquatic systems and fish communities. Obviously wood is important in providing fish cover for resting, protection from high flows, protection from predators or, in the case of predators, ambush cover. What is often overlooked is the role of wood in trapping fine organic debris and retaining nutrients in the stream. Wood is also important in providing a substrate and food source for aquatic invertebrates which, in turn, provide food for fish. All of these functions are critical components in aquatic production and have a significant effect on fish community health.

Overgrazing - as described by Leopold - reduces vegetation cover along streambanks needed to slow and spread flood flows and filter out suspended sediments. It also reduces plant vigor, thus reducing root mass needed to hold stream banks together. Eventually, plant communities themselves change from those which build and hold streambanks to those which do not.

Overgrazing to the point of severely reducing upland vegetative cover further aggravates this by radically altering the hydrograph. The ability of the watershed to store and slowly release precipitation which falls on it is greatly reduced. Stream flows from precipitation events show higher and shorter peaks as well as an increase in the frequency of "moderate" flow events. This translates into increased energies which stream channels must accommodate. Couple this with a reduced ability to handle even normal water energies brought about by the removal of wood from the stream and the alteration of plant communities needed to hold streambanks and a picture of severe degradation emerges.

These effects are long lasting. Altered hydrographs last long after proper grazing management is applied to the watershed. Channel and floodplain degradation is also long lasting. Reestablishment of riparian plant communities to plant species and vigor capable of building and protecting streambanks must also occur. With severely degraded conditions this is not a quick process. Even once the hydrograph is restored, degradation will likely continue. Complete restoration will not occur until wood can become reestablished in the stream channel and meander belt at levels similar to that which existed prior to clearing and snagging.

As mentioned above, log drives indicate timber harvest in upstream areas of the stream's watershed. If these harvest activities significantly reduced the volume of large timber along stream courses - which was typical during the era of log drives - and on unstable landslide prone areas, then the input of large wood into the system will be reduced for a time period measured in decades if not centuries. Additionally, clearing and snagging operations were not confined to removal of large wood but also included anything, e.g. boulders, etc., that represented an obstacle to free downstream passage of logs, i.e., anything that logs could hang up on. Why is this last bit important? Movement of large wood through a system and it's incorporation into the stream bed and meander belt is controlled by these "obstructions". Thus, the restoration of wood to a stream system after removal of these "obstructions" requires the reintroduction of these "hard points". In the case of boulders this reintroduction is likely from landslides or individual rock tipping neither of which can generally be described as frequent events, at least in our time sense.

Once the chain of events briefly described above occur then recovery to pre-disturbance

conditions will necessarily take centuries if not millennia. A recent study modeling the recovery from clearing and snagging of an Australian river estimated that the wood removed represented 1,500 years of accumulation. The authors went on to estimate that 30,000 years will be required after recovery of the vegetation to pre-disturbance conditions before wood volume in the river and it's meander belt will be similar to pre-disturbance levels.

If this is not enough, determining the effects of human related activities on aquatic species can be problematic when habitat requirements for species involved have been determined through observations taken in greatly altered watershed and stream conditions. In these cases it is difficult if not impossible to determine with any certainty whether the species is actually utilizing habitat which it evolved with, or if the current preferred habitat is simply the best currently available and may not have been preferred habitat under original conditions.

In reviewing species information on these species few if any references predated 1950 and most of the early references appeared to deal with presence/absence rather than habitat requirements. Review of accounts of watershed and stream conditions in the Blue River watershed and other watersheds in Arizona and New Mexico uncovers a picture of major degradation of watershed and stream conditions by the early 20th Century. Additionally, the presence of nonnative aquatic predators may have caused a shift in habitat utilization thus further complicating matters. This leaves one with what may be a mix of original preferred habitat requirements , i.e., those which are in the evolutionary make up of the species, and those which are more likely "make do ".

Therefore, when approaching the recovery of the spikedace and the loach minnow in the Blue River we must;

1. take a watershed perspective,
2. accept that total elimination of "take" may not be necessary and may even, in some cases, hinder recovery of the species,
3. understand that the species' current habitat preferences, as we know them, are likely different than what they were pre-disturbance,
4. accept that recovery of watershed conditions under which the species evolved and gave rise to "true" habitat preferences will be measured in centuries if not millennia and that even reliable trend detection in instream habitat parameters will take decades, therefore,
5. in addition to monitoring of long-term objectives short- and mid-term parameters (surrogates) must also be identified and monitored to provide short- and mid-term trend information for use in adaptive management.

So far we've discussed "legacy" effects in the Blue River watershed. While it is important to identify these "legacy" effects and understand they can have a major effect on how long restoration will take we can't just throw up our collective hands and proclaim that there's nothing that can be done now. Efforts must be made to remove or manage the stressors to watershed processes for which we are responsible. Current management activities must be carefully designed to ensure that effects from them do not exacerbate existing conditions. They must also be designed to allow recovery of compromised watershed processes. The remainder of this

report will shift from a general discussion of T&E management and watershed processes toward more site specific opinions on current conditions, recovery time frames, and monitoring recommendations .

IV. Specific Findings

Hydrology and Erosion/Deposition

Access of frequent floodflows to floodplains, sinuosity, width/depth ratio, and gradient all play an important role in how well a stream dissipates energy. The hydrology attributes and processes of the Blue River have been highly altered, and contribute to the functional-at-risk to nonfunctional condition of most of the drainage.

In most of the Blue River drainage, frequent floodflows are not capable of reaching a relatively flat floodplain for energy dissipation, sediment deposition, and periodic flooding of riparian vegetation. The channel has downcut and widened, so the amount of water that used to just fill the channel and start spilling out onto the floodplain, is now held within the deeper, wider channel. Very high, more infrequent floodflows do reach the terraces where high flow channels are present. Reduction in resistance forces (loss of large woody material and riparian vegetation, especially woody species), and increase in water velocity (channelization, diking) resulted in an increase in energy of water flow. The increased energy eroded the streambed and streambanks. This would have been significant enough to produce rapid vertical adjustments to the channel network, disconnecting the channel from it's frequent floodplain. The lowering of the base level in San Francisco River could have also contributed to a headcut moving up the Blue River and it's tributaries, since many of the same activities occurred there also. All of this leads to more water in the channel and less water infiltrating into the floodplain aquifer during moderate flow events.

Tom Subirge reported to us that he has looked at several years of air photos, and sinuosity has not changed over the years of the photos, even with the instability of the downcut and widened channel. It makes sense because of the moderately narrow canyon controlling the valley bottom width and sinuosity. The channel instability has also eroded the streambanks so that the channel is wider than expected for the landform and stream size.

Potential Vegetation

There is no formal riparian vegetation classification for the Blue River and associated drainages that we are aware of. Therefore, our prediction of potential vegetation is general and based on general soil/landform - climate-hydrology relationships, literature pertaining to similar ecosystems, and field experience.

Present vegetation, remnant landforms and soils, and naturally high coarse sediment inputs resulting from faults and slides suggest the majority of the Blue River except possibly the upper most reaches and higher tributaries are a woody plant potential with little hydrophytic herbaceous vegetation except in select valley bottom positions. Narrow leaf cottonwood, alder and

associated willows will dominate streambanks in the upper reaches and Fremont cottonwood, Arizona sycamore and associated willows will dominate streambanks and overflow channels in the lower reaches. The two cottonwoods can co-dominate at mid elevations and hybridization is common.

Although both cottonwoods can regenerate to some extent by root sprouts and cuttings, the preponderance of true stand regeneration is usually from seedling establishment on emerging point bars and islands formed by higher spring flows coinciding with seed drop. Successful regeneration is determined by a specific set of stochastic events and site conditions, generally averaging about once every 17 to 22 years (although there can be high variation). Regeneration site formation and relative stability is greatly enhanced by large wood contributions from older established stands.

As regeneration sites aggrade and channel migration occurs these sites typically experience a reduced frequency of flooding . This results in a gradual site progression toward drier sites dominated by mid to mature age classes of cottonwoods (and sycamore at mid to lower elevations) and mesic shrubs then to mature to decadent cottonwoods and associated tree species such as ash, walnut, oaks, conifers or mesquite depending on elevation with upland shrubs and grasses . In the wider valley bottom areas, enough fines may be accumulated over time to develop perched water tables that support cienega wetland vegetation such as sedges, rushes , cattails, etc. in depressional areas and overflow channels. The mix (complex) of sites will depend on valley width and relative stability of channel and floodplain sites.

We are reasonably sure that the Blue River is large wood dependent for maintaining an equilibrium in erosion/deposition characteristics and providing sufficient stability to allow site development in the moderately confined to wide valley bottom positions. With sufficient large wood to enhance stability, we estimate that the widest areas such as the area just below the Blue Range Primitive Area (Baseline) would have a potential to become a patchwork cottonwood gallery/cienega wetland complex with a mixed hardwood or mesquite Bosque outer margin. The moderately confined segments of the Blue (by far the greatest type) would have the potential to develop a distinctive scroll pattern of cottonwood gallery age class development with a thin margin of conifer-hardwood mixed forest or mesquite bosque in places depending on elevation.

Highly confined areas such as at Blue Box Bridge below Blue Camp would have only willows and young cottonwood age classes except for individual trees in protected areas. Periodic high flows through these confined areas tend to break pole size cottonwoods as soon as they start becoming rigid. The result seems to be a perpetuation of a willow/cottonwood sapling mix.

<u>Present Vegetation Conditions and Potential for Recovery</u>

As discussed above vegetation and site characteristics along the entire length of the Blue River appear to have been severely altered by a number of impacts although there is one area above Blue Camp that still appears to have many of the characteristics expected at potential. These impacts include but may not be limited to:

- Removal of large wood. Discussions on-site and early photographs (no date) confirm that the Blue River was used for log transport down river to be used as charcoal for mining operations. Undoubtedly the channel was "cleared" for transport. The removal of anchored trees combined with the log floats typically destabilize banks and scour any new regeneration.

- Continuous year long grazing was the historical norm in this area as it was throughout most of the Southwest. Continuous year long grazing would have limited recruitment of bank stabilizing vegetation and future supplies of large wood.

- Road construction, reconstruction, and maintenance further destabilized sites and again the channels were probably kept clear of large wood to minimize flood damage.

- Channelization and diking most likely induced or at least contributed to down cutting of the channel which reduced water tables and stressed any remaining vegetation. Much of channelization and diking was probably associated with agricultural development which would have further reduced riparian functions of dissipating energy, trapping sediments and storing water while other segments appeared to be mostly associated with road protection and maintenance.

Some, if not all, of these impacts appear to be continuing to one degree or another on some private lands within the Blue River catchment.

Despite the near complete de-stabilization of the Blue River, there is remarkable evidence of recovery, especially on the Forest Service administered lands. Cottonwood and willow regeneration is doing well on Forest Service segments above Blue Camp. One segment was rated as functioning properly; however, excess bed load and associated scour are still limiting plant establishment in other places. There are also segments where excess browsing by big game may be inhibiting new recruitment of woody species. Excess browsing was especially notable in open meadow sites with only a remnant of or on newly forming woody plant component. The majority of the segment above Blue Camp is still definitely on an upward trend if browsing doesn't continue to increase.

Excess browsing was also noted on one tributary to the Blue River above Blue Camp. All reproduction on Bush Creek was from root sprouts of older trees. All sprouts now exhibit an "arrested" growth form that has many short bushy stems with none being allowed to become dominant and form a new main stem. There has been a short period of escapement from browsing in the recent past (10 to 20 years?). A very few middle aged stems reflect a "released" architecture reflected by a multi-stemmed, bushy base with one stem finally escaping browse long enough to become dominant. Bush Creek is currently in non-functioning condition and will remain so until escapement from browsing of seedlings and sprouts is accommodated. We are not sure if this is common on other tributaries or not.
At least three age classes of recruitment were observed in classical scroll patterns on the moderately confined segment (the majority) of the Blue River below the Primitive Area. An on site investigation at the confluence of the Blue and San Francisco Rivers revealed good reproduction of both cottonwood and Gooding willow and some reproduction of sycamore on the

tail ends of bars. No limitations of browsing by either wildlife or domestic livestock were observed. Newly colonized bars are still very susceptible to erosion, especially in the absence of a large wood matrix, so periodic setbacks must be expected during recovery. It is estimated that at least three to four more regeneration episodes (60 to 80 years plus or minus a decade or two) will be required before sufficient material will be available to start overcoming the accelerated channel dynamics we now see and allow development of successional sequences in equilibrium with channel evolution.

Some concern was expressed by Forest Service employees over an apparent lack of plant recruitment on the wider valley bottom type immediately south of the Primitive Area boundary (Baseline). An on-site investigation revealed some recruitment by root sprouts or buried logs along overflow channels. No browsing of young sprouts was observed. Some wetland development was also evident along the easternmost overflow channel which is farthest from the current active channel. Abundant (for the site) and vigorous upland vegetation was present throughout the rest of the bottom. We suspect that the constantly reworked alluvium is presently so coarse and homogenous that drainage is presently too rapid and the present water table is just low enough because of lack of confinement to preclude cottonwood and willow seedling establishment along the majority of overflow channels. We also suspect that over time with periods of low to moderate high flows, enough stratification of fine and coarse sediments will occur to "perch" flood flow water long enough to allow seedling regeneration. Discontinuities of two or more soil particle size classes between strata tend to inhibit percolation downward and initiate lateral soil water movement. Blockages and retention of large wood will eventually accelerate the process. This may be the reason for the wetland expression beginning to develop in the eastern most channel. A blockage (old beaver dam?) apparently has been protected from disturbance long enough to collect finer sediments and hold water longer. Proximity to the valley toe and additional moisture from a side drainage may also be contributing. Continued development within the rest of the valley bottom toward a cottonwood gallery/cienega complex is impossible to predict, but appears to be progressing. Progress will be slow at best and periodic setbacks with periods of high flows can be expected regardless of management.

Grazing Management

Management for woody species regeneration should be the emphasis for the main stem of the Blue River and higher gradient tributaries. Timing, frequency, and intensity of browsing by both livestock and wildlife are probably the most critical factors affecting woody plant recruitment. Herbaceous sedges and rushes, either alone or in association with woody vegetation, may be also be locally important in some lower gradient reaches and certainly in headwater reaches originating in meadows or historical meadow environments. Duration and intensity of domestic livestock grazing are probably the most critical factors to consider in these reaches.

We understand that there has been elimination of livestock grazing in some allotments on the Blue River and significant reductions or changes in seasonal livestock use in others. Much of the current upward trends is undoubtedly due to these changes. However, there may be additional opportunities to enhance both resource conditions and livestock production. We did not have the opportunity to review allotments in depth, so discussions here will be general.

Cattle, in particular, are central place foragers with a focus on water (although there is a large array of factors influencing selection of one place over another.) Any opportunity to develop off stream water should be evaluated. Although piped water, dirt impoundments, or other developed water away from streams is often preferable for distribution, even developments close to a stream can be beneficial. Well water from shallow aquifers near streams is often cooler in the summer and warmer in winter than that in the stream and not only reduces trailing and/or trampling on streambanks but often enhances livestock performance. Even water piped (solar or gravity fed) from the stream a short distance to a metal tank with a float shutoff or return flow to the stream is often preferred, especially where there are steep or overhanging banks. Every time a cow goes to a trough to drink is one less time it is trailing and searching the stream bank.

Even where there is adequate water, duration in a pasture can become a problem any time topography or weather tend to congregate cattle in the bottoms. Duration in a pasture is often directly linked to repeated and excessive grazing of desirable species, especially in riparian areas. As availability of preferred forage species becomes limited (usually about 3" height), they tend to start utilizing less preferred species such as willows and cottonwoods before they move out to less desirable locations. This not only inhibits riparian recovery but also has negative effects on daily gains or maintenance of the animal for the producer. The solution is often more pastures and more moves in some kind of deferred or rest rotation strategy. In some areas during the active growing season, more moves can be accommodated without more pastures if there is sufficient regrowth. There is a lot of variability, even within a season, but we find that duration in a pasture is often limited to a few days to a few weeks in the hot season and a month to month and a half otherwise before riparian areas start to suffer. Reducing numbers doesn't usually solve anything by itself in these situations; it merely concentrates the problem areas. Even a small number of cattle can damage riparian areas when environmental conditions favor cattle congregating in the bottoms.

Fences are expensive to construct and maintain so the cost is unjustified on many allotments. Some livestock operators are opposed to the extra time and potential stress on livestock from frequent moves. The primitive area and wilderness areas and other uses may also inhibit additional fences. Despite the drawbacks of common allotments, some smaller permittees have reformed grazing associations simply to provide more management alternatives. Another option that is becoming more popular is low stress livestock handling techniques that allow movement and placement in rotational strategies without fences or with minimal fence. Again, some smaller operators have combined herds to make management more efficient. Although the techniques are time intensive, some groups and individuals have found that they could more than pay for the cost of a full time handler with improved gains and savings on other operating costs such as fence maintenance, sickness and death loss, improved conception rates, supplements and so on. Occasionally, increased livestock numbers have been accommodated with intensive management.

Seasonal grazing strategies such as early spring or winter (dormant season) grazing may provide some opportunities but they also have some drawbacks that must be considered. Early season grazing can minimize livestock use in the riparian area if there is cold air drainage that tends to keep stock out of the bottoms. Most of the growing season is deferred from grazing on any

account. However, woody plant seedlings are easily uprooted if livestock by chance do use the area and repeated use on the uplands at this time can have deleterious effects, particularly on cool season plants. Other areas such as higher elevation, low gradient segments may be susceptible to soil damage. Dormant season use provides complete growing season deferment, but residual vegetation can be a problem where the potential includes sedges and rushes. Use on willows and cottonwoods can also become excessive at this time. Physiologically, above ground shoots of cottonwoods and possibly some willows can be completely removed during the dormant period without apparent damage to the root system. However, these systems need large wood which cannot be accrued without considerable escapement of young shoots to increase tree density.

There are other strategies that might be considered on an individual basis. However, any strategy needs to be monitored with particular attention to woody plant recruitment and increases in bank stability.

<u>Road Management</u>

Transportation systems within the Blue River watershed have provided access for decades and allowed utilization of the land and its many valuable resources. Yet these roads, and especially the county road along Blue River and its tributaries, are affecting watershed health and are often linked to accumulated adverse environmental impacts to this broad river system.

When conditions throughout the entire watershed are considered, however, it becomes evident that roads are one of many problems that need addressing but may not be "at the top of the list" of the watershed stressors. This means that care must be taken to avoid focusing too much time and effort on road problems at the expense of addressing larger watershed scale problems that left unattended will assuredly lead to the extinction of the listed species.

This statement is not intended to minimize effects this road, or others, has had or continues to have on the Blue River watershed. For example, the county road confines portions of the Blue River, straightening segments, increasing energy of water flow, and accelerating erosion of streambed, channel banks, and indirectly responsible for reactivating erosion processes (debris torrents) in tributary channels. Because of the proximity of the county road to the Blue River, however, problems will continue and stabilization efforts road maintenance and repair will be an ongoing challenge. Field observations revealed several opportunities to improve current road condition and decrease negative impacts to the river.

Field Observations

- The county road confines portions of Blue River which has straightened channel segments, increased water flow energy, and accelerated streambed and channel bank erosion.

- High road density in the upper portion of the watershed, with extensive ditchline and channel crossings has increased drainage density (channel network) of the watershed.

- Sediments, from road surfaces and cutslopes are collecting in ditchlines and during rain events are being transported to culverts and the Blue River stream network.

- Several culvert outlets and inlets are not armored to reduce water velocities and prevent erosion of cut and fillslopes.

- No evidence of sidecasting road materials during regular maintenance operations. Excess materials, however, are being bladed to road edge which has resulted in extensive network of berms. These berms are channelizing water flow on the road's surface. And during rain events channelized surface water flows behind these berms until it finds a low-point to exit the road. Exits points, vulnerable to erosion (i.e. erosive soils lacking vegetative cover), have formed rills and gullies and occasionally become chronic sources of surface erosion and sediment transport to Blue River.

- In addition to creating berms, excess road materials have been incorporated into the road prism, widened segments of the county road. This road widening has been a slow and subtle process and resulted in further confinement of Blue River, increased energy of water flow, and accelerated erosion of streambed and channel banks.

- Moderate to steep road gradients without any crossdrains. Evidence of overland flow - surface water without crossdrains with rill and gully formation on fillslopes.

- Oversteepened and erosive fillslopes.

- Significant sediment contributions from ephemeral channels. Hypothesis: road alignment straightened segments of Blue River, increased velocity and instability (erosiveness) of streambed channel banks, and reactivation of old debris landslides (ephemeral channels). Loss of upland and riparian vegetation within these channels plays a significant role in condition of these tributaries but road crossings also play a role. Changes in flow patterns to Blue River are partly responsible for reactivating erosion processes (debris torrents) in tributary channels.

- The low water crossings, within Blue River watershed, have been very effective in transporting debris, bedload, and high flows during high water events. However, their typical location in low gradient reaches, which naturally experience deposition, can mislead the observer. The presence of deposition following high flow events would seem to indicate the low water crossing is the cause of the deposition. In reality, if the crossing does not raise the elevation of the streambed, natural scour and deposition processes will continue. The deposition observed is the result of landform changes, i.e., streambed gradient and valley/channel width. If the deposition was not removed from the stream

channel by road maintenance activities, these materials would be moved downstream with the next similar high flow event and replaced by new deposition of upstream origins. Therefore, the use of low water crossings over culverts - or even bridges if design restricts the channel as often is the case - have minimized impacts to Blue River by decreasing the amount of fill placed directly in the channel which would have raised streambed elevation. In addition these low crossing fords have helped restore riparian area functions where road crossings often create cutoff channels, interrupt stream flow, fragment wildlife habitat, and are responsible for fish passage problems. It was observed, however, that approaches to these crossings are chronic sources of sediment. Sediment transport can be reduced by using surfacing techniques to bind or seal roadway material. Refer to Solutions for additional information.

- Observed remnants of riparian road crossing failures.

Solutions

Despite near complete de-stabilization of the Blue River riparian corridor, there is remarkable evidence of recovery, especially on the Forest Service administered lands. Some, if not all, of these impacts appear to be continuing to one degree or another on some private lands within the Blue River catchment. The following road management opportunities are recommended to ensure continuance of this recovery trend by disconnecting or minimizing riparian disturbance.

- Road removal and/or realignment. Whenever the opportunity presents itself, identify and pursue road removal or realignment opportunities. Realignment, or relocation of road segments, would require the old road prism be sufficiently removed to allow for a more natural drainage network. This technique has the potential for many positive outcomes and include, but are not limited to, restoring floodplain structure and function and reducing risks and occurrence of chronic road failures.

- Outsloping. To reduce channelized drainage on the road surface and decrease sediment loading to water bodies consider outsloping. This technique has application where the management goal is to gradually move water across the slope rather than channelizing the surface flow. As earlier described, years of ditch cleaning has resulted in road segments with accumulated roadside berms, increased road width, and accelerated sediment movement.

Outsloping can repair this situation by eliminating inside ditches. The cross slope of an outsloped road varies from 3 to 5 percent and depends on road profile, maintenance level, and traffic service level. In areas where roads become icy, or snow covered, outsloping may pose a danger to drivers. Travel speeds, design vehicles, season of use, and steepness of fillslopes all factor into the decision whether or not to use outslopes. To remedy these safety concerns, consider outsloping segments of the full road length.

- Roadway dips. A second drainage recommendation is installation of roadway dips. These dips modify roadway drainage by altering the road template and allowing surface water flows to frequently disperse across the road. The presence of erosion, ditch sloughing, culvert failures, cascading effect from overtopping culverts, high maintenance costs, and hydrological connectivity (decreasing channel network) indicate an opportunity to install roadway dips. Roadway dips may used in lieu of, or in addition to, culverts for cross drainage, especially where existing culverts are prone to failure or require high maintenance. Roadway dip spacing is critical. Placement may be at ditch relief culverts

  or change in grade. This technique reduces road maintenance, but grader operators need to understand the need of the dip so that they do not blade out the structure. Where fish passage is a concern, roadway dips alone are not an appropriate treatment. Roadway dip design and construction will vary by road management objectives. Consider traffic limitations and ensure vehicles can be accommodated by ensuring the proper length of the dip. Generally, the steeper the slope, the greater the length of the dip. In some cases riprap placement, and/or asphalt, can be used to harden the dip and disperse water for wet conditions or year round use roads.

- Crossdrains and waterbars. Manage water and sediments with installation of driveable crossdrains and waterbars. Remove shotgun culvert outlets and armor these outlets with rock to reduce water energy and erosion (vertical instability/downcutting).

- Culverts. Recommend identifying chronic washout areas and upgrade these crossings

upgraded to withstand high-flow events. Conduct hydrologic studies for these critical areas and determine culvert base size, number, and spacings based on your findings. Consider opportunities for installing low crossing fords, in place of culverts, whenever possible.

In all road improvement designs, consider opportunities to provide unrestricted passage for adult and juvenile fish through road or channel crossing structures. Field inventory information has revealed the presence of isolated fish populations either above or below many culverts. Unrestricted fish passage can be provided at these sites by installation of bridges, bottomless arch culverts, larger full pipe culverts, or box culverts. The type of structure, length, width, and installation grade can be determined by stream and site surveys, including using the Forest Service's Fish Passage X-crossing software. Size and design of the fish passage structure needs to consider the swimming speed capabilities of the primary or target fish species. In addition, the structure needs to consider various flow regimes. The installation needs to be done at the lowest flow period of the year to reduce the amount of heavy equipment disturbance (sedimentation and turbidity).

Providing for unrestricted fish passage can result in significant fish access to spawning and rearing habitats. Other desired outcomes and benefits of these structures could be more efficient passage of high flows and bedload, and an increase in channel complexity (channel meander and geometry).

- <u>Ditch treatments</u>. Sediments, from road surfaces and cutslopes are collecting in ditchlines and during rain events are being transported to culverts and the Blue River stream network. Cutslope stabilization alternatives include soil bioengineering and biotechnical solutions such as live cribwall construction. Ditch treatment alternatives include construction of vegetated, rock-lined, and lead-out ditches. Vegetated and rock-lined ditches reduce velocities and capture sediment. Lead-out ditches are built to carry water away from the roadway, onto the forest floor, allowing infiltration and dispersion of water. The softest approach to developing vegetated ditches is to not heel or pull the ditch with a grader, except when absolutely necessary. Roadside ditches should be large enough, and have adequate relief drain spacing, to carry runoff from moderate storms. Ditch gradient between 2 to 8 percent slopes are usually better performers. Slopes greater than 8 percent provide runoff waters with too much momentum and erosive force and will require more ditch relief. Slopes of less than 2 percent drain water too slowly.

- <u>Surfacing treatments</u>. To reduce sediments from the low crossing ford approaches, as well as all other travelways, consider surfacing techniques to bind or seal roadway material. Surface treatments include:

    - Native material.
    - Gravel. Imported material is placed over native subgrade.
    - Soil stabilization. Incorporated into the top 4 to 6 inch of material, these products bind soil particles creating a stable interlocking course.
    - Chip seal is an application of asphalt followed immediately with aggregate

and used on low to moderate volume roads. Usually last 3-6 years before requiring reapplication.

  - Asphalt paving is a surface course of aggregate coated and cemented together with asphalt cement, supported by an aggregate base course.

- Energy dissipaters and debris racks for culverts. To address erosion at culvert inlets and outlets consider installation of energy dissipaters and debris racks. Examples of dissipaters include riprap, vegetated ditches, concrete or steel baffles, and tiger teeth. These applications can be used wherever a need to reduce velocity form a culvert outlet. They protect steep slopes and erosive soils; they disperse flows and prevent channeling or undercutting at the culvert outlet. Energy dissipaters and aprons function on single or multiple culverts (arrays). They work during storm and normal flow events.

  An apron of coarse rock installed on a cut of fillslope can prevent erosion and undercutting at culvert outlets, and at other drainage outlets as shown here.

  Debris racks at culvert inlets may prevent clogging. They can have negative repercussions if they are not maintained, i.e. become clogged, backing up water, water may then overtop the road and cause road failure. Only install debris racks when regular maintenance is possible.

- Mobile rock crusher. For areas with over-widened roadways and excessive berming, consider use of a mobile rock crushing machine. Waste rock traditionally sidecast over, or bermed on the roadway shoulder, can be crushed into quality surfacing material. The mobile rock crusher requires equipment to rip up the road, pull bermed material and waste rock from the road edge, then windrow the material. Once completed, an average rock crusher pass will reconstruct a 14-foot wide roadway with a 4-inch depth crushed material. Crushers produce angular crushed rock, provide better interlock, and reduce loss of surfacing material due to water runoff or traffic use.

Road maintenance reconstruction cost, using these crushers, is generally one tenth the cost of traditional gravel resurfacing.

- Slope rounding and revegetation.
  To address over-steepened, erosive fillslopes, and over-widened road segments consider slope rounding and revegetation. This involves laying back hillslopes to a natural angle of repose to reduce runoff, the onsite/offsite sediment transport, and to promote establishment of vegetation. Seeding and planting often follows slope rounding.

- Sources of native materials. Removal of gravel from the Blue River for stockpiling and later use in road maintenance was discussed in some depth during the field visit. Several potential locations were visited and their suitability in relation to stream function discussed. We won't attempt to chronicle each site as Forest Service staff were taking notes of specifics. In general, it was our opinion that there do exist opportunities to use stream gravel as a source of native materials. However, removal of gravel should be limited to designated sites only (as we understand is being proposed). Inspection, evaluation, and designation of source sites should be done on location and by a team made up of at least County, FS, and USFWS. Since removal and fill permits will likely be required it would expedite matters to include ADEQ if possible. The following points should be addressed when evaluating the suitability of a potential site for gravel removal.

  1. Will the removal destabilize the channel either on site, upstream, or downstream of the site?

  2. Gravel should not be removed from within the active channel of the Blue River or perennial tributaries.

  3. No loss or damage of vegetation within the riparian area should occur.

  4. When contemplating removal of gravel from the mouths of intermittent or

ephemeral channels the potential for destabilizing the tributary channel resulting in the formation of a headcut must be carefully evaluated.

In summary, all road management strategies must be carefully designed to reduce fine sediment input into streams, avoid adding to the effective stream network, and examine opportunities to reduce road density, ensure unimpeded fish passage to suitable habitat, and minimize road maintenance and repair activities which either remove riparian vegetation or prevent it's establishment.

An important point regarding "roads" and watershed effects needs to be made here. Typically road management strategies are limited to roads appearing on the Forest Development Transportation Facility. While this makes sense from a transportation management standpoint it falls short of adequately addressing all effects to watershed processes. Any route used by vehicles has the potential to adversely affect watershed processes therefore should be considered. Even foot and horse trails can contribute to degradation of watershed processes.

Monitoring

Channel morphology and associated habitat characteristics for the loach minnow as well as water quality parameters can be expected to change very slowly over time with measurable change detectable only after a period of years and in many cases decades rather than annually. Additionally, the dynamic nature of these systems leads to recovery rates that are something less than even and constant. Changes in these parameters can be expected to exhibit periods of short-term downward trends embedded within a long-term upward trend. This can lead to the erroneous conclusion that the aquatic/riparian system is exhibiting a negative trend in recovery.

This is best illustrated by examining the stages a stream often must progress through when restoring stream function to a channel which is now non-functioning. To restore channel stability these streams must adjust channels to once again come into balance with the larger watershed processes occurring. This involves streambank and floodplain rebuilding as well as changes in sinuosity and gradient, to name a few major processes occurring. As this is occurring the stream will necessarily experience cycles of channel narrowing during periods of low flows and low sediment input (absence of stream altering storm events) followed by significant sediment deposition during stream building events. These later events result in an upbuilding of the stream channel and associated floodplain which in turn results in a rewidening of the stream channel and apparent negative trend in width:depth ratios. These cycles repeat until the stream once again has established a channel and floodplain adequate to handle the streamflows and bedload produced by the larger watershed processes.

Only after the stream channel has stabilized can the aquatic habitat parameters be expected to begin to exhibit easily measurable improvement. Typically, this stabilization will first become evident through a change in herbaceous vegetation followed by an increase in the woody shrub component, assuming of course that woody shrubs are within the site potential. This improvement in stabilizing vegetation will then lead to streambank stabilization and decreases in width/depth ratios (Clarey ,Hall and Bryant, Elmore and Beschta). The rapidity with which

streambank stabilization will occur will, of course, be dependent on other processes occurring simultaneously, i.e., reestablishment of sinuosity and gradient appropriate to the larger watershed scale setting. Once this phase of recovery is well established then and only then can it be reasonably expected that other parameters such as water temperature, pool frequency, etc., will begin to exhibit measurable improvement.

Once natural stream recovery is examined in this manner it becomes evident that these parameters must be monitored over the long-term to assure that objectives are ultimately attained but that monitoring them over the short- to mid-term will provide little useful information measuring the success of implemented management and may well lead to erroneous interpretations and premature and potentially adverse modifications to management strategies.

In our opinion, a nested sequence of monitoring techniques and time frames is necessary to adequately evaluate progress toward long term objectives and still stay within budget and personnel constraints. This should employ a minimum number of short term (annual) and mid term (3-5 years) measurements or observations that provide a relatively high confidence that we are progressing toward long term objectives (often decades away) without directly measuring everything all the time. As discussed above, In the case of the Blue River and its tributaries, channel morphology and associated habitat characteristics for the loach minnow, water quality and similar concerns will be constantly changing but with no predictability or confidence until certain vegetation characteristics have changed substantially <u>and</u> certain (relatively) infrequent stochastic events have occurred. After baseline data has been gathered for future comparison, it is imprudent to monitor these elements on any frequent basis unless substantial changes in vegetation community have occurred.

<u>Short Term Monitoring (or annual monitoring)</u>

Short term monitoring usually includes at least actual use (number of livestock and dates in a pasture) and utilization of key species. We find that utilization mapping is also a useful tool for evaluating opportunities for adaptive management. However, common methods of determining utilization on uplands are often inappropriate for riparian vegetation or do not provide the best indicator for potential riparian recovery. We agree with much of the recent literature that stubble height of key hydrophytic herbaceous bank stabilizing vegetation such as broadleaf sedges and many rushes is a better indicator than utilization where the potential exists for these species. Recent trials in the Pacific Northwest by Dr. Hall have determined that utilization on most willows and other woody species with indeterminate leader growth simply can't be performed with any reliability, either between measurements by the same individual or between individuals.

Although no one stubble height is optimal for all processes, a minimum of 4" on hydrophytic species along the stream edge (greenline) appears to be a good compromise. Six inches is often recommended on more degraded streams where faster recovery is desirable. These heights are often used as end of growing season standards but also need to be in place whenever high flows can be expected, such as during periods of late summer thunderstorms. These recommended heights do not have to be applied to preferred forage species such as Kentucky bluegrass or upland grasses growing on well drained soils within the riparian area. However, stubble heights of these

species can be a good indicator of when willows, cottonwoods, and coarser herbaceous vegetation will start to be taken in higher amounts that potentially affect riparian recovery as well as animal performance. Animal preference or selectivity will shift to other species to maintain forage intake somewhere around a 3" or lower stubble height on the preferred species simply because the tongue sweep to pull forage into the mouth becomes ineffective. Stubble height is easy for producers and agency people alike to see and estimate, so thresholds should less likely be exceeded compared to traditional utilization methods providing people are taught the right indicators.

Use on woody vegetation is the main concern on the main stem of the Blue River and the lower tributaries. In place of traditional utilization estimates, we recommend using "incidence of use" which is just a percentage of stems or leaders bitten within reach of livestock. Sprout and young age classes are of particular concern. We have observed that 25-30% incidence of use has been used successfully although there is little published research to support it. In order to keep incidence of use on woody species at an acceptable level, operators need to know the behavior of their own herds in their allotments (and private pastures). In some locations cattle appear to use herbaceous vegetation almost exclusively to a certain level, then switch to a high proportion of browse (especially sprouts and young) all at once. In these cases, we recommend moving as soon as cattle preference changes or the use will be exceeded. Other places, browse use seems to be linear but inversely proportional to availability of herbaceous vegetation.

Mid Term Monitoring (or long term monitoring at moderate intervals)

We fully support the procedures described in Monitoring the Vegetation Resources in Riparian Areas (General Technical Report RMRS-GTR-47, 2000) by Dr. Alma Winward. These procedures include cross section vegetation, greenline vegetation, and woody plant regeneration.

All three procedures are appropriate on the upper reaches of the Blue River and probably the majority, if not all of the tributaries of the Blue. However, the excessive channel dynamics in the main stem of the lower Blue may preclude any useful information being obtained from greenline measurements until further in the recovery process. Cross section vegetation and woody plant regeneration might still be appropriate, but you might also consider aerial photography as an alternative for cross section vegetation analysis. Woody plant regeneration is the critical factor in this system so you might even consider some additional work to document regeneration on overflow or abandoned channels as well as the current channel.

Long Term Monitoring

Due to the dynamic nature of the system and past extreme destabilization of the Blue River and many tributaries it can be expected that exceptionally long recovery time periods for channel morphology, aquatic habitat, and water quality parameters will be experienced by the watershed. Because of this we strongly suggest that until photo points and aerial photography show apparent significant changes in channel width and stability monitoring studies of the above parameters be limited to acquisition of baseline data accompanied with some easily collected ongoing data of some parameters such as water temperature (accompanied with air temperature, of course) and

flow (in many cases this could be simply high water surface elevation gauges). However, we caution against attempts to prematurely analyze this data and make management decisions based on it. We have seen statistical power analyses of these types of natural resource data , i.e., high signal to noise ratio, which suggest that decades are required before the analysis has sufficient power to provide useful accuracy or precision.

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